The Los Alamos Neutron Science Center—An Essential Facility for Los Alamos National Laboratory and for Stockpile Stewardship

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What is LANSCE?

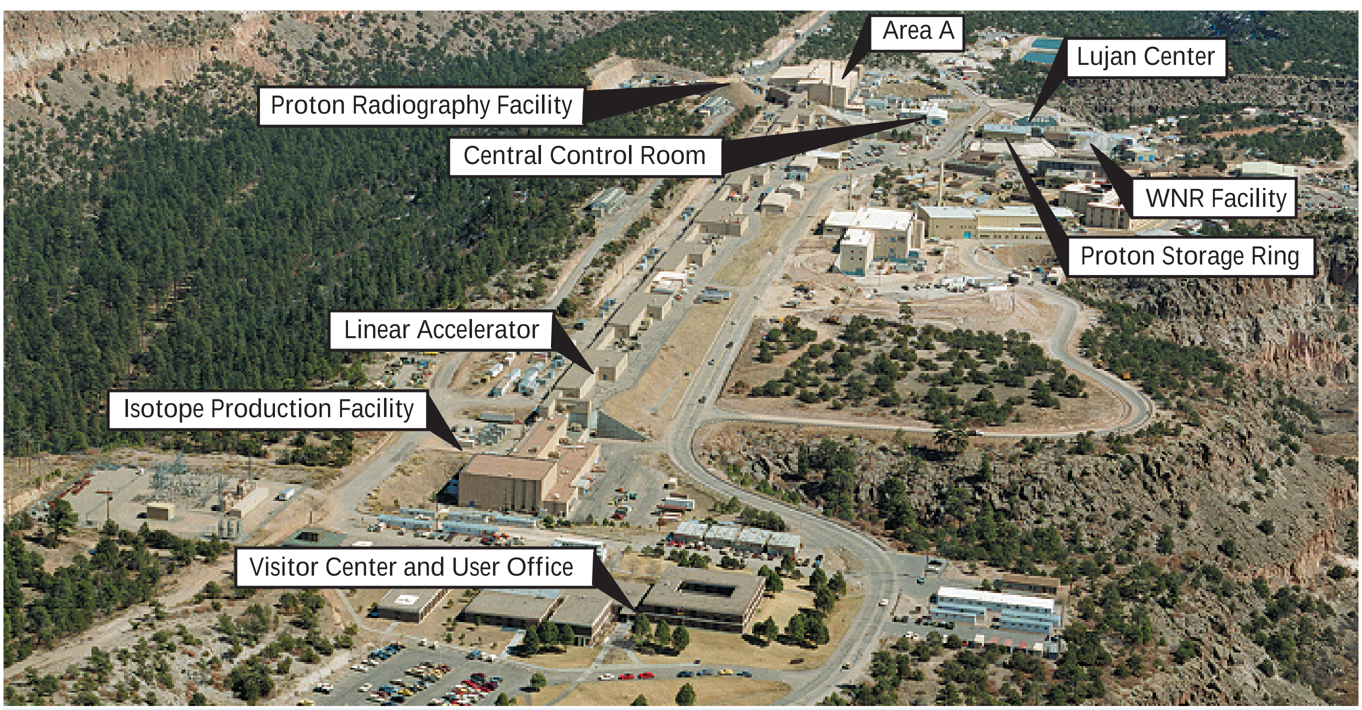
The Los Alamos Neutron Science Center, or LANSCE, is an accelerator-based facility that provides extraordinary research opportunities in basic and applied research using neutrons. LANSCE generates neutrons by striking heavy-metal targets with the 800-MeV proton beam of its linear accelerator (linac), giving high-intensity neutrons over 16 orders of magnitude in energy. In addition to neutrons, scientists use the 800-MeV proton beam to image dynamic systems, opening up completely new options for stockpile stewardship and providing a new tool to better understand the aging and performance of weapons-systems components. Three major Department of Energy (DOE) and National Nuclear Security Administration (NNSA) stakeholders—Defense Programs (DP); Office of Science (SC); and Office of Nuclear Energy, Science and Technology (NE)—have a vested interest in the three major experimental capabilities:

- a dedicated facility for proton radiography (pRad);
- the Lujan Neutron Scattering Center (Lujan Center), which uses a source of moderated neutrons (with meV to eV energies) primarily for neutron-scattering research in condensed-matter physics, including material science and biology; and
- the Weapons Neutron Research Facility (WNR), which uses a high-energy neutron source (100 keV to 800 MeV) for research in nuclear science and technology, as well as for the irradiation testing of industrial components such as integrated circuits.

These facilities provide the most versatile defense, basic, applied, and industrial research capability in the world.

In addition to these existing facilities, construction of an Isotope Production Facility (IPF) to help satisfy the national need for biomedical radioisotopes is under way. Beginning in 2003, LANSCE will provide medical radioisotopes, many of which are not otherwise available in the United States.

In addition to producing tangible achievements in science and technology, the LANSCE complex has been one of the most important "windows" to the academic community and a source of many of the brightest young scientists at Los Alamos National Laboratory (LANL). It is estimated that LANSCE and its predecessor, the Los



↑ *The Los Alamos Neutron Science Center.*

Alamos Meson Physics Facility, have served as a gateway to nearly 10% of the workforce at LANL.

Technical and Infrastructure Accomplishments

LANSCE has made significant accomplishments in each of the experimental facilities in recent years, including the following:

- pRad has been developed from a concept to an operational technology and is an extraordinary tool for making quantitative measurements of high explosives and other weapon-relevant-material behavior under extreme dynamic conditions. These measurements have had a direct and tangibly beneficial influence on decisions associated with the national stockpile.
- A decade-old problem was resolved through accurate measurements of nuclear properties of plutonium. As a result, weapons designers have developed a new weapons-performance model to understand an important difference between computer-yield simulations and underground-test yields. This gives designers confidence in a very large set of test data that were previously unused and provides a new test of predictive capability.
- Neutron resonance spectroscopy has revealed, for the first time, both the temperature and particle velocities within a shocked metal.
- The world's highest density of bottled ultra-cold neutrons (UCNs) was achieved using a novel solid deuterium source.
- The Lujan Center increased its cold-neutron intensity by up to a factor of 4, becoming the first spallation neutron source worldwide to employ this novel production technique.
- Four new world-class instruments for neutron scattering were commissioned by teams involving many universities and national laboratories.

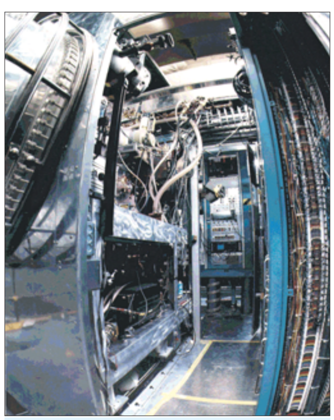
The first protons were accelerated by the LANSCE linac in June 1972. Since that time, the mission has evolved but the physical infrastructure has never been funded at a level to keep pace with the evolution of standards for operation of such facilities. To correct some of these problems, LANL has invested in selective improvements, including two new cooling towers, and is preparing justification for other projects. During 2001, a peer-reviewed bottom-up cost estimate was completed. That estimate forms the basis for reinvestment decisions necessary to have LANSCE reach full potential as a world-class user facility for defense and civilian research.

One benefit of the initial infrastructure investments was that LANSCE recently completed the most successful and productive running period in its history as an NNSA and SC National User Facility. Operating with greater than 90% availability, 7 days a week, 24 hours a day for 6 months, LANSCE supported more than 200 experiments and served over 500 users.

Particle Beam Production

High-intensity proton linear accelerator. LANSCE is the world's most versatile spallation neutron source. Its high-intensity, 1-MW proton linac is the heart of many LANSCE activities. The LANSCE high-intensity linac can simultaneously produce and accelerate protons (H^+) and H^- ions (which have two electrons orbiting each proton) to energies of 800 MeV. The three-stage, half-mile-long linac is capable of providing H^+ beam with an average current of up to 1 mA at a repetition rate of up to120 Hz and a peak current of up to 17 mA. The H^- beam has an average current of up to 100 μA at a repetition rate of 20 Hz and a peak current of 20 mA at the Lujan Center and up to 5 μA at 100 Hz at WNR.

↑ *Cockroft-Walton injector.*



↑ *Inside Cockroft-Walton injector.*

↑ *The LANSCE linear accelerator.*

The first stage of the accelerator contains injector systems for each kind of particle (H^+ and H^-). Each injector system has a 750-keV Cockroft-Walton generator and an ion source. The two ion sources produce H^+ and H^- particles inside high-voltage domes. After they leave the injector, the two ion beams are merged, bunched, and matched into a 201.25-MHz drift-tube linac for further acceleration to 100 MeV. The third and longest stage of the accelerator (800 m) is the side-coupled-cavity linac, where particles are accelerated to their final energy of 800 MeV.

The particle beams from the linac are separated and directed down three main beam lines leading to several experimental areas, including the pRad Facility, the Lujan Center, and the WNR Facility. Operators can control the H^+ and H^- beams separately, allowing most experiments to run simultaneously.

Proton Storage Ring. The Proton Storage Ring (PSR) converts H^- linac macropulses of approximately 750-ms duration into short (0.13-μs, full-width at half maxmum), intense H^+ bursts, which are sent to the Lujan Center neutron-production target 20 times a second. These short and intense bursts provide the capability for precise neutron time-of-flight (TOF) measurements for a variety of experiments.

Neutron production. The nuclear reaction process that occurs when protons strike targets, such as tungsten, is known as spallation, which expels many neutrons from target nuclei. For 800-MeV incident protons, about 20 neutrons per proton are ejected. The short and intense bursts of spallation neutrons are directly used for nuclear-physics experiments at WNR. Spallation neutrons are also slowed down in moderators before they are used at the Lujan Center.

Moderators. For most neutron-scattering research at the Lujan Center, the initial spallation-neutron energies are too high, and correspondingly, their wavelengths are too short, for investigating condensed matter. For this reason, the neutrons must be "cooled down" before being used for scattering experiments. This process is accomplished by allowing the neutrons to interact with a moderator—a light material with a large scattering cross section such as water or liquid hydrogen. Neutrons enter the moderator (close to the neutron source), and in a series of collisions, lose energy to moderator atoms. After a few tens of collisions, the neutron energies are similar to the thermal energy of atoms in the moderator. Thus neutrons are emitted from the moderator with an average energy determined by the moderator temperature. The average energy of the neutrons from a water moderator at room temperature is approximately 25 meV, whereas the average energy from the liquid-hydrogen moderator at 20 K is approximately 5 meV. The energies and wavelengths (around 1.8 Å for 25 meV) of these neutrons match excitation energies and interatomic spacings of matter, respectively, and are thus very useful for neutron-scattering experiments that probe material structure and excitations.

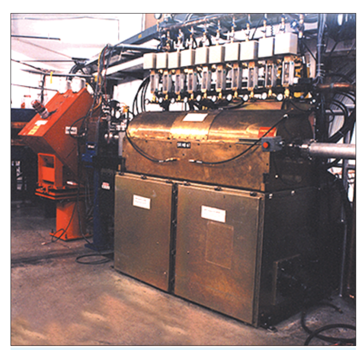
A National User Facility

As a National User Facility for defense and civilian research in radiography, nuclear science, and condensed-matter science, LANSCE hosts scientists from academia, industry, national laboratories, and other research facilities around the world. Scientists apply for beam time by completing a proposal, which is submitted for appropriate peer review before beam time is granted. Information about accessing the user facilities at LANSCE is available at http://lansce.lanl.gov/index_ext.htm.

Lujan Center. Researchers from universities, industry, LANL, and other research facilities use low-energy neutrons at the Lujan Center for materials science and engineering, condensed-matter physics, polymer science, chemistry, earth sciences, structural biology, and nuclear-science research. A unique split-target design and flux-trap moderators yield a higher peak neutron flux at the Lujan Center than any other spallation neutron source.

↑ *Accelerator control room.*

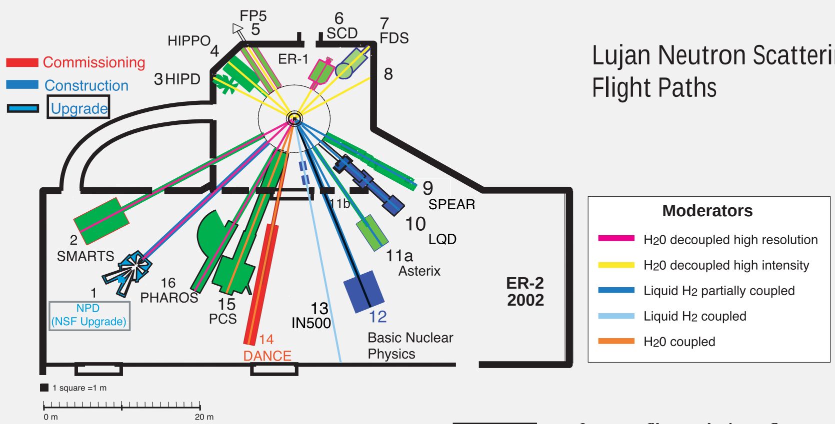
↑ *The klystron gallery.*



↑ *Proton Storage Ring.*

Overview

Most of the flight paths (FPs) at the Lujan Center are equipped with spectrometers for determining the atomic, molecular, and magnetic structures, as well as the vibrational and magnetic excitations of materials. Of the 16 FPs, 10 are used for condensed-matter science and engineering, 1 is used for transmission spectroscopy, 2 are used for nuclear science, 1 is undergoing a major upgrade, and 1 is under development. A brief description of each FP is listed below.



FP1 **Neutron Powder Diffractometer (NPD)** is used for studies of complex structures, internal strain measurements, and phase transformation.
Thomas Proffen, 505-665-6573, tproffen@lanl.gov

FP2 **Spectrometer for Materials Research at Temperature and Stress (SMARTS)** instrument is used for measurements of spatially resolved strain-fields, phase deformation and load transfer in composites, the evolution of stress during temperature (or pressure) fabrication, and the development of strain during reactions (such as reduction, oxidation, or other phase transformations).
Mark Bourke, 505-665-1386, bourke@lanl.gov

FP3 **High Intensity Powder Diffractometer (HIPD)** is designed to study the atomic structure of materials that are available only in polycrystalline or noncrystalline forms.
Robert Von Dreele, 505-667-3630, vondreele@lanl.gov

FP4 **High-Pressure-Preferred Orientation (HIPPO)** instrument is a new high-intensity powder diffractometer for high-pressure and texture measurements.
David Bish, 505-667-1165, bish@lanl.gov

FP5 **FP5** is used to study the Doppler shift and broadening of low-energy nuclear resonances in materials under extreme conditions and for structural studies using transmission Bragg diffraction.
Vincent Yuan, 505-667-3939, vyuan@lanl.gov

FP6 **Single Crystal Diffractometer (SCD)** has been used to study the structure of organometallic molecules, unique binding within H_2 crystal structural changes at solid-solid phase transitions, magnetic-spin structures, twinned or multiple crystals, and texture.
Yusheng Zhao, 505-667-3886, yzhao@lanl.gov

FP7 **Filter Difference Spectrometer (FDS)** is designed to study energy transfers to vibrational modes in a sample by measuring energy changes in the scattered neutrons.
Juergen Eckert, 505-665-2374, juergen@lanl.gov
Luc Daemen, 505-667-9695, lld@lanl.gov

FP9 **Surface Profile Analysis Reflectometer (SPEAR)** is used with an unpolarized neutron beam to study solid/solid, solid/liquid, solid/gas, and liquid/gas interfaces.
Greg Smith, 505-665-2842, gsmith@lanl.gov
Jaroslaw Majewski, 505-667-8840, jarek@lanl.gov

FP10 **Low-Q Diffractometer (LQD)** is designed to study large structures with dimensions in the range from 10 to 1000 Å. It measures a broad Q range in a single experiment without physical changes to the instrument.
Rex Hjelm, 505-665-2372, hjelm@lanl.gov

FP11a **Asterix** provides a polarized-neutron beam for studies of magnetic materials, using reflectometry and diffraction. Samples can also be subjected to high magnetic fields.
Mike Fitzsimmons, 505-665-4045, fitz@lanl.gov

FP12 **FP12** is used for a fundamental nuclear physics experiment to precisely measure the asymmetry of the emission of gamma (γ) rays from the capture of polarized neutrons by protons.
David Bowman, 505-667-7633, bowman@lanl.gov

FP13 **IN500** is a prototype instrument employing novel techniques to enhance inelastic cold-neutron spectroscopy at spallation-neutron sources.
Margarita Russina, 505-667-8841, russina@lanl.gov
Ferenc Mezei, 505-667-7633, mezei@lanl.gov

FP14 **Detector for Advanced Neutron Capture Experiments (DANCE)** is used for the study of neutron radiative capture by radioactive nuclei in support of the Stockpile Stewardship program and for nuclear astrophysics.
John Ullmann, 505-667-2517, ullmann@lanl.gov

FP15 **Protein Crystallography Station (PCS)** is a single-crystal diffractometer designed for structure determinations of large biological molecules.
Paul Langan, 505-665-8125, langan_paul@lanl.gov
Benno Schoenborn, 505-665-2033, schoenborn@lanl.gov

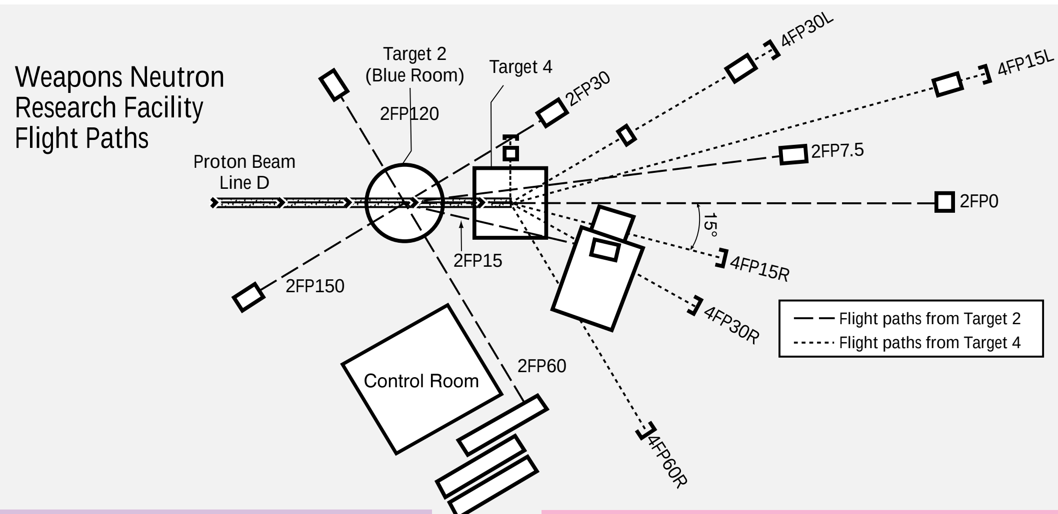
FP16 **PHAROS** is a high-resolution chopper spectrometer designed for neutron-inelastic-scattering studies of Brillouin scattering, magnetic excitations, phonon densities of state, crystal-field levels, chemical spectroscopy, and measurements of the scattering function $S(Q,\omega)$.
Robert McQueeney, 505-665-0841, mcqueeney@lanl.gov

WNR Facility. At the WNR Facility, high-energy neutrons and protons are used for basic and applied research in nuclear science and weapons-related measurements. WNR consists of two target areas: Target 2 and Target 4 and their associated FPs. At Target 2, also known as the Blue Room, proton-induced reactions can be studied using the linac or the PSR proton beam. In addition, Target 2 is used for a variety of proton-irradiation experiments. This target consists of a low-background room with 7 FPs (one is unused). Experiments in the Blue Room can exploit the variable-energy feature of the linac using proton beams from 250 to 800 MeV.

Target 4 is the most intense high-energy neutron source in the world. Target 4 consists of a "bare" (unmoderated) neutron production target and 6 FPs with distances ranging from 10 to 90 m and at angles of 15° to 90° with respect to the proton beam. The shape of the neutron spectrum ranges from a hard (high average energy) spectrum at 15° to a softer (lower average energy) spectrum at 90°. The time structure of the proton beam can be modified to produce neutron pulses with different spacings for particular experiments.

The WNR neutron beams from Target 4 complement those produced at the Lujan Center because the WNR beams have much higher energy and shorter pulse duration. With both capabilities, LANSCE is able to deliver neutrons with energies ranging from small fractions of an eV to 800 MeV.

Each FP's name identifies the target and the direction of the FP with respect to the proton beam. For example, 4FP15R is a FP that starts at Target 4 and is 15° to the right (15R) of the incoming proton beam.



Target 2 (Blue Room) Experiments

In **neutron resonance spectroscopy**, the PSR beam is used to produce an intense single pulse of neutrons for measuring the temperature and particle velocities of dynamic systems at different times during their evolution. The temperature is obtained by measuring the Doppler broadening of low-energy neutron resonances.

Single pulses from the PSR beam are used in **shock diagnostics** to study the shock induced by the incident beam on a liquid mercury target for the Spallation Neutron Source (SNS).

A **UCN source** using solid hydrogen is being developed.

A program is under way to study the **enhancement of superconductivity in high-temperature superconductors** caused by the introduction of defects from proton-induced fission reactions of the heavy element constituents of the superconductor.

Target 4 Flight Paths

FP90L	This FP is used to measure neutron-proton capture cross-sections important for understanding Big Bang nucleosynthesis.
FP30L	This FP has two experimental stations. The first station is at approximately 20 m from the production target and is where accelerated neutron testing of semiconductors by industrial researchers can be done. The second station is at a distance of 40 m and was most recently used for high-energy neutron radiography.
FP15L	This FP provides the highest neutron energy resolution. At present, the approximately 90-m-long FP is being used for dosimetry, neutron transport, and (n,2p) experiments.
FP15R	The (n,d) scattering experiment, which uses a liquid hydrogen target, is located on this approximately 18-m-long FP.
FP30R	Most recently, experiments on this approximately 20-m-long FP studied neutron-induced reactions for nuclear-level-density studies.
FP60R	The GEANIE spectrometer consists of approximately 26 Compton-suppressed, high-resolution germanium gamma-ray detectors and is located on this approximately 20-m-long FP. The GEANIE instrument is used to address issues of nuclear structure, spectroscopy, and cross-section measurements for both stockpile stewardship and basic science.

Proton Radiography Facility. In Area C, scientists use H^- beam from the linac as a radiographic probe for creating multiple high-spatial-resolution images of imploding or exploding objects with sub-microsecond time resolution. Protons interact through strong electromagnetic forces allowing the simultaneous measurement of different material properties, such as material density and composition distributions. Protons have several properties that are advantageous for these types of experiments, including high penetrating power, high detection efficiency, very little scattered background, and inherent multi-pulse capability. In addition, large distances are possible from the test object and the containment vessel for the incoming and transmitted beams, therefore reducing the background calculation from scattered particles.

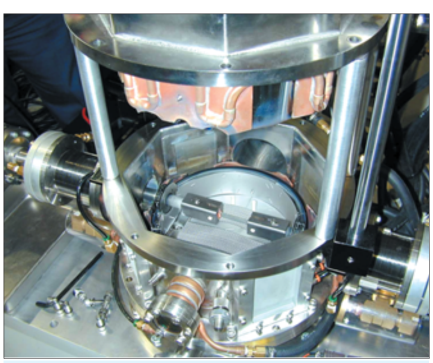
LANL scientists have developed magnetic optics; fast, integrating, large-area detectors; and containment vessels both to solve important weapons-physics problems and to lay the groundwork for an Advanced Hydrotest Facility capability.

Ultra-Cold Neutron Facility. In Area B, scientists are planning to direct the H^- beam onto a small tungsten target to produce neutrons. These neutrons will be moderated to very low energies by layers of polyethylene at liquid nitrogen temperature (77 K) and liquid helium temperature (5 K) surrounded by solid deuterium to produce ultra-cold neutrons (UCNs). UCNs have sufficiently low energy that they cannot penetrate materials; thus, they undergo total reflection at all angles. As a result, the UCNs produced by this target/moderator configuration will be "trapped" in "bottles" or directed along guide tubes. The UCN team achieved the current world's record for the density of UCNs stored in a bottle: 100 UCNs/cm^3. The team is proposing a full-scale UCN source to be installed at LANSCE. The predicted steady-state UCN density of 300 UCNs/cm^3 is approximately 8 times the highest existing UCN production source capability of 41 UCNs/cm^3 measured at the Institute Laue-Langevin research reactor in France. Design and initial stages of construction of the full-scale UCN source and experiments are now in progress. This new source will allow the team to measure neutron-decay asymmetry with previously unattainable precision.

Programs and Projects

Short-Pulse Spallation Source Enhancement Project. The goal of this collaborative project, funded by DOE/NNSA/DP and DOE/SC, was to significantly upgrade LANSCE capabilities by increasing the neutron-source intensity and by constructing additional neutron-scattering spectrometers at the Lujan Center. DOE/NNSA/DP funded the accelerator upgrade to provide 200 μA of H^- beam current to the Lujan Center target. The major components of the accelerator upgrades are a new H^- ion source and injector system, an upgraded radio-frequency (rf) bunching system, a new inductor and additional multipole magnets in the PSR, and new magnets in the Lujan Center beam line. These improvements have resulted in greater neutron flux for experiments at the Lujan Center. DOE/SC funded the construction of three advanced neutron-scattering instruments at the Lujan Center. Scientists from academia, industry, and national laboratories built these instruments for research by the team members and general users. Two instruments—SMARTS (Spectrometer for Materials Research at Temperature and Stress) and HIPPO (High-Pressure Preferred Orientation)—were funded by Basic Energy Sciences (BES) and commissioned in the summer of 2001. The Office of Biological and Environmental Research (OBER) funded the PCS (Protein Crystallography Station), built by the Bioscience Division and commissioned in 2001. All three new instruments will enter the user program in the 2002 run cycle.

↑ *SPEAR user with Neutron Confinement Shear Cell.*



↑ *An inside look at the SMARTS open furnace.*

↑ *Scientists prepare a sample on NPD.*

Spallation Neutron Source. The Spallation Neutron Source (SNS) project, under construction at Oak Ridge National Laboratory (ORNL), is a major DOE initiative designed to develop the world's most intense pulsed neutron source for neutron-scattering experiments. The design and construction of the SNS is being carried out by a collaboration of six DOE laboratories: ORNL, LANL, Argonne National Laboratory, Brookhaven National Laboratory (BNL), Lawrence Berkeley National Laboratory, and Jefferson National Laboratory. LANL's main responsibilities are to (1) design, construct, deliver, and help install and commission a normal-conducting linac, which consists of 87-MeV-drift-tube and 186-MeV-coupled-cavity accelerating systems; (2) provide beam-physics analyses for the entire linac; (3) provide more than 100 MW of rf power for the entire linac; and (4) develop the experimental physics and industrial control system for the linac.

Isotope production for medicine and science programs. To ensure a steady supply of medical isotopes, DOE/NE is funding the construction of a new Isotope Production Facility (IPF) to replace the existing facility at LANSCE. Construction of the new $16.5 million IPF began in February 2000 with expected completion in 2003. Combining the new IPF output with similar isotope production capabilities at BNL will supply adequate, year-round, accelerator-produced medical isotopes. These isotopes are needed to perform 36,000 diagnostic procedures daily and 50,000 therapies annually, along with 100 million laboratory tests annually. The DOE Office of Isotopes for Medicine and Sciences estimates the annual value of these procedures to the medical industry at between $7 to $10 billion. The Chemistry Division at LANL has produced some of these medical isotopes, such as strontium-82 and germanium-68, at LANSCE for more than 20 years. Using a portion (~100 MeV) of the 800-MeV LANSCE proton beam, the new IPF will irradiate a wide range of materials underground, including rubidium chloride, gallium, and other targets. Irradiated targets will then be shipped to the Chemistry Division for processing.

Advanced Hydrotest Facility. A proposed Advanced Hydrotest Facility (AHF) is an important future capability of the NNSA/DP Stockpile Stewardship program for three-dimensional studies of fast dynamic events. The AHF would consist of a 50-GeV proton synchrotron with an adequate injection system constructed in a tunnel some 100 m below the LANSCE linac and an array of transport lines to supply proton pulses to illuminate a dynamic test object. A set of large-aperture magnetic lenses will image the protons passing through the test object at many times, creating a radiographic "movie." Those images will give LANL and Lawrence Livermore National Laboratory (LLNL) scientists critical information necessary to assess the safety, performance, and reliability of our aging nuclear-weapons stockpile.

The LANL has been designated by DOE/NNSA/DP as the lead organization for planning, constructing, and commissioning the AHF as a National User Facility for providing unique data crucial to nuclear-weapons certification in the coming decades. During the past two years, the LANSCE AHF project team, in collaboration with LLNL, other DOE laboratories, industry, and university partners, developed options and performed design trade-off studies for a facility that would meet all future requirements of the weapons community. In 2001, the project began engineering development activities of key system components—a fast-rise anharmonic kicker-modulator, large field-of-view superconducting quadrupole lenses, and the composite inner vessel. The project is pursuing pre-conceptual studies in anticipation of entering the conceptual design phase.

Advanced Accelerator Applications Program. The Advanced Accelerator Applications Program has been tasked by the DOE with the design of an accelerator-driven facility to transmute radioactive waste. A

↑ *A view of HIPPO detectors.*

↑ *WNR's new "ICE House" experimental building.*

↑ *Users analyze data in ICE House.*

subcritical system coupled to a high-energy accelerator, which contains large quantities of minor actinides to be incinerated, is unlike any other system ever assembled. This system poses significant technical challenges that must be overcome before a large-scale facility can be built. A research and development program, which has been established to accomplish this mission, includes the development of several experimental facilities to study fuel development, structural materials and system integrity, facility operations and control, and the physics of coupled systems. In support of the research and development program, a series of experiments at LANSCE were identified to address pertinent issues related to corrosion of structural materials, target-neutron-yield data, and basic cross sections.

Laboratory-Directed Research and Development program. The Laboratory-Directed Research and Development (LDRD) program supports internally proposed, innovative research and development work that extends LANL's science and technology capabilities. The selection process is highly competitive, with a comprehensive review by peers or LANL managers and selection based on innovation and scientific merit in a mission context. The LDRD program has two major components: (1) directed research, which provides funds to make larger strategic investments in research and development projects, and (2) exploratory research, which provides funds to conduct staff-initiated research and development that is highly innovative in scope and often at the forefront of their disciplines. LANSCE has many projects that owe much of their success to LDRD support, including the following:

- test of "Big Bang" nucleosynthesis model predictions by measurement of the $(n + p \rightarrow d + \gamma)$ cross section,
- measurement of (n,γ) cross sections for unstable nuclei of interest to s-process nucleosynthesis,
- synthesis and characterization of superhard materials,
- dynamic science of Earth processes,
- cold-neutron spectroscopy at LANSCE (the IN500 project),
- spin injection to semiconductors,
- short-range order in materials, and
- computational modeling.

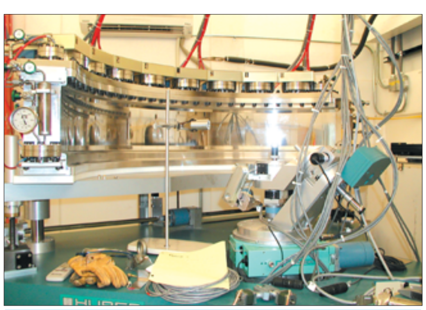
In addition to these LDRD projects within LANSCE, there is also substantial LANSCE involvement in projects within other LANL divisions, including the following:

- neutron- and accelerator-based science,
- advanced-neutron-detection technology for nuclear science, and
- nuclear-isomer physics.

Sponsors

LANSCE addresses important issues for each of the major DOE stakeholders—DP in the NNSA, SC, and NE.

Issues for stockpile stewardship. The Stockpile Stewardship program at LANSCE supports the operation of the 800-MeV linac and its neutron-production targets. Defense research takes advantage of a wide range of LANSCE capabilities to provide the DOE/NNSA/DP community with information critical to the national stockpile stewardship mission: maintaining safe, secure, and reliable nuclear deterrence without nuclear testing. Among the capabilities being exploited at LANSCE are neutron scattering, proton and neutron radiography, neutron resonance spectroscopy, and neutron-induced nuclear-reaction measurements. The Stockpile Stewardship program at LANSCE has been designed to



↑ *PCS detectors and sample rest.*

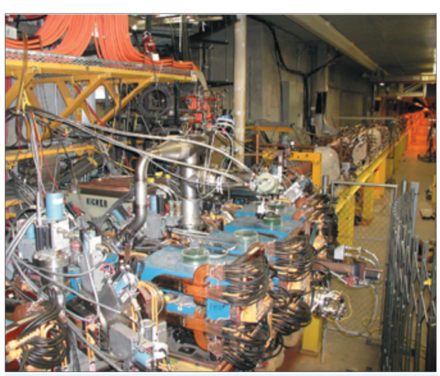
↑ *LANSCE pRad beam line.*

↑ *Scientist prepares pRad experiment.*

give the traditional weapons design and engineering community capabilities to study issues related to the stockpile. LANSCE researchers provide fundamental data to inform and guide the development of full-fidelity physics modeling of nuclear explosions. This modeling is being implemented on a new generation of supercomputers—the fastest in the world—at the DP laboratories as part of the Accelerated Strategic Computing Initiative. In addition, LANSCE research is contributing to the development of advanced manufacturing processes that will be important for stockpile refurbishment activities in the future. Current projects featured in this report are listed in the following table.

A National User Facility for neutron scattering. The DOE/SC/BES has a major responsibility for planning, designing, constructing, and operating national-user facilities. These user facilities offer world-class capabilities for basic and applied research to researchers from universities, national laboratories, and industry. Acquiring new knowledge that cannot be obtained by other means enables the determination of behavior of matter. The experiments at these user facilities embrace the full range of scientific and technological endeavors, including chemistry, physics, materials science, geology, biology, and engineering science. The Lujan Center contributes to this objective through the development of world-class spectrometers and by supporting forefront research. Some current activities in support of these goals are featured in this report as listed in the following table.

↑ *Asterix magnet.*

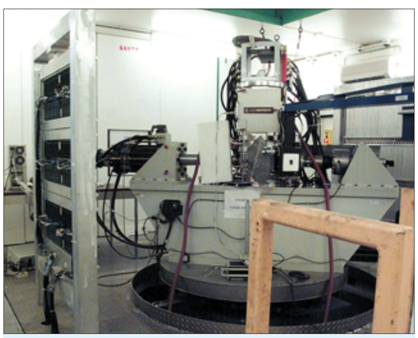


↑ *New IPF kicker magnet.*

↑ *Instrument scientist standing on base of the NPD instrument.*

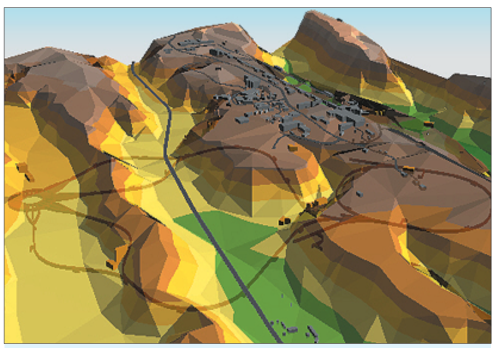
Overview

Nuclear-physics research. The mission of the nuclear-physics program within the DOE/NE is to promote nuclear-physics research through the development and support of basic-research scientists and facilities. Nuclear-physics research seeks to understand the fundamental forces and particles of nature as manifested in nuclear matter. Current projects featured in this report are listed in the following table.



↑ *SMARTS translator and detector.*

↑ *IPF hot-cell window (outside view).*



↑ *AHF conceptual layout.*